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Cross-sectional observational study

Analysis, use, and application of ultrasound-guided percutaneous electrolysis: a cross-sectional study

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ABSTRACT

Objective: To analyze the clinical application of percutaneous electrolysis (PE) among physiotherapists, evaluating its frequency of use, adverse effects, application criteria, technical parameters, and perceived effectiveness.

Materials and Methods: Descriptive cross-sectional study through an anonymous online survey aimed at physiotherapists trained in PE. Demographic data, clinical practice information, and safety data were collected using closed and open-ended questions. Descriptive statistics were used with frequency analysis and measures of central tendency.

Results: Forty-nine physiotherapists participated, with a mean age of 32.9 ± 8.4 years. 69.4% had more than 60 hours of PE training, and 95.8% used ultrasound guidance. The most frequent adverse effects were pain during application (45.8%) and minor bruising (10.2%). 36.7% of the physiotherapists interviewed reported having caused a vasovagal syncope on some occasion. 87.5% applied intensities of 1–3 mA, with durations of 1–3 seconds. 91.7% combined PE with other invasive techniques or therapeutic exercise. The majority considered PE to be more effective than other non-invasive treatments for pain reduction, functional improvement, and structural changes.

Discussion: In clinical practice, a high level of homogeneity in the application criteria is observed, although the sample is influenced by the training methodology and the low representation of the initially calculated sample. Emphasis is placed on the need to establish more standardized protocols.

Conclusions: PE is perceived as safe and effective in the studied sample and is commonly used in combination with other therapies, both invasive and non-invasive. The results support its use and safety, although larger studies are required, as the lack of a representative sample limits the extrapolation of the results shown.

Keywords: ultrasound-guided percutaneous electrolysis, invasive physiotherapy, national survey, clinical practice, effectiveness, safety.

1. Introduction

Percutaneous electrolysis (PE) is based on the application of a galvanic current through a solid needle, which generates a local electrochemical reaction that can induce a biological environment favorable to tissue repair. The administered electric charge causes immediate changes in the cellular microenvironment, including alterations in pH, the formation of cathodic products, and a controlled inflammatory response that stimulates processes of degradation and subsequent reorganization of the injured tissue. This electrical stimulus has been associated with the activation of inflammatory mediators and the modulation of the extracellular matrix, promoting the synthesis and alignment of collagen fibers during the early stages of regeneration. Together, these mechanisms provide a plausible pathophysiological framework that could explain the clinical outcomes observed in chronic tendinopathies and other soft tissue disorders. It is frequently performed under ultrasound guidance for precise localization of the target tissue and to avoid adverse effects⁽¹⁾.

PE is mainly used in the treatment of tendon, muscle, ligament, and bursa conditions, although it is also used for nerve-related issues⁽¹⁻⁴⁾. Its mechanism of action is based on the application of a galvanic current through the needle, without the administration of exogenous substances. This electrical stimulus triggers a non-thermal local inflammatory response, increasing cellular activity and facilitating repair of the affected area^(1,5,6).

Despite the increasing use of the technique in clinical practice, consensus on its safety, effectiveness, and application parameters remains limited due to the heterogeneity of published studies⁽²⁾. This study has reported mild, transient adverse effects, including bruising, post-treatment pain, and vasovagal responses. However, only a few publications have reported the frequency of these events in a real clinical setting. Additionally, inconsistencies have been identified in the reporting of adverse effects related to PE. In many intervention studies, these events are not reported, and, in those that do, mild effects are usually described that are not specific to the technique itself but rather to the invasive procedure.

Likewise, in the use of PE, there is variability in the selection of target tissue, the frequency of administration, the parameters used, and the combination with other therapies. Furthermore, most of the available studies have focused on the application of PE in tendons, this being the most extensively researched structure⁽⁷⁻¹¹⁾.

In this context, this study aims to analyze the clinical practice of PE among physiotherapists, exploring the frequency of use, the criteria for selecting the target tissue, the application parameters, the perception of effectiveness, and the frequency of adverse effects (both those related to being an invasive technique and those specific to PE). To this end, an online survey was conducted targeting physiotherapists with experience in applying PE. The results will allow us to understand the current state of its clinical use, identify application patterns and potential areas for improvement, and determine the percentage of procedures performed with ultrasound guidance, thereby contributing to the optimization and safety of this technique in musculoskeletal physiotherapy^(7-10,12).

2. Materials and Methods

2.1 Study Design

A descriptive cross-sectional study was conducted using an online Spanish survey, following the recommendations of the CHERRIES checklist for online surveys. The study aimed to understand the current state of clinical use of PE, its safety, and the associated adverse effects, as well as to identify application patterns, possible areas for improvement, and the percentage of procedures performed with ultrasound guidance, to contribute to the optimization and safety of this technique in the field of musculoskeletal physiotherapy⁽¹³⁾.

The study protocol was approved by the Ethics Committee of San Pablo CEU University (approval granted on May 6, 2025, code 1001-25 TFM), and the survey was completely anonymous. Detailed information was provided on the estimated survey duration (approximately 7 minutes), data storage procedures, the identification of the researchers, and the study's purposes. Only the principal investigator had access to the security key used to protect the collected data, and no information that could identify participants was collected. Only data related to the clinical practice of PE were collected, including the participant's training, years of experience, application criteria, and perception of the technique's safety. Basic demographic data, such as age and sex, were also collected. No personally identifiable information was requested, thus ensuring the anonymity and confidentiality of the data. Participants did not receive any benefits or compensation for their participation.

2.2 Sample size, population study, and inclusion criteria

The sample consisted of physiotherapists who used PE in their clinical practice. Inclusion criteria: 1) Being a licensed physiotherapist, 2) Having received training in the use of percutaneous electrolysis, 3) Being professionally active at the time of completing the survey, either in the public or private sector, and 4) Agreeing to participate voluntarily after reading the study information. Exclusion criteria: 1) Not having fully completed the survey or 2) Having provided inconsistent or invalid responses.

To determine the sample size, the formula $n = t^2 \times p \times q / d^2$ was used, where t^2 represents the critical value of the standard normal distribution, p is the proportion of individuals who meet the inclusion criteria, q is the proportion who do not meet them, and d^2 is the squared margin of error. A 95% confidence level was assumed ($t = 1.96$), maximum population variability ($p = 0.5$, $q = 0.5$), and a 5% margin of error ($d = 0.05$), resulting in an estimated minimum sample of 382 correctly completed surveys.

No minimum number of hours of musculoskeletal ultrasound training was established, nor was the ultrasound competency level of the participants assessed, which is considered a limitation of the study.

The survey was distributed between May 6 and June 9, 2025. Participants were contacted through various channels: 1) via email to contacts in the MVClinic database and 2) via email from the researcher Diego Aznar to professional physiotherapist associations. Table S1: *Licensed physiotherapists by year and gender*.

2.3 Survey Preparation

The survey was conducted in two phases. In the first phase, a preliminary version was developed based on previous studies of invasive techniques in physiotherapy, which was subsequently modified following a critical review. Subsequently, a final version was distributed via Microsoft Forms after pilot testing with 15 physiotherapists. The final survey consisted of six sections, each on a separate page. The first section explained the study, demographic information, experience, and training. The second collected data on the frequency of adverse effects related to pain, using a Likert scale based on percentage ranges: Never (0%), Rarely (<10%), Sometimes (10–30%), Often (30–60%), and Frequently (>60%), and the third evaluated the frequency of adverse effects related to PE. The fourth section included questions about the clinical use of PE, the fifth addressed technical application parameters, and the sixth addressed clinical outcomes and perceptions of the treatment.

2.4 Survey content

The survey included: 1) Explanation and data handling (purpose of the study and confidentiality of the data collected); 2) Demographic and professional data (age, gender, country, professional experience, training in PE, frequency of clinical use, methodology, usage experience); 3) Frequency of adverse effects, both pain-related (during application, post-puncture, symptom worsening, treatment discontinuation due to pain) and related to PE application (bleeding, hematoma, nerve or visceral puncture, myoedema, vasovagal reactions, infections, or allergic reactions); 4) Clinical use of DN (treated tissues, target tissue selection criteria, use of ultrasound, combination with other therapies). 5) Application parameters (intensity, duration of the stimulus, impacts, dosing system, frequency and number of sessions, clinical improvement, structural change) and 6) Clinical outcomes and treatment perception (perceived effectiveness, reasons for discontinuation, results, interactions, comparison with other techniques).

2.5 Data Collection Procedure

The survey was distributed via email, social media, and professional physiotherapy associations in Spain. Participation was entirely voluntary, and data confidentiality was ensured. The estimated response time was between 7 and 10 minutes.

2.6 Statistical Analysis

The data were collected using Microsoft Forms and imported into SPSS v.21 for analysis. Descriptive statistics were applied to summarize the data, using frequencies and percentages for categorical variables and means with standard deviations for continuous variables, with 95% confidence intervals. Descriptive analyses were conducted for each survey item, and the data were analyzed both globally and by subgroups (training hours, years of clinical experience, percentage of patients treated with PE, and weekly dedication). Chi-square tests were used to assess differences between subgroups. The level of statistical significance was set at $p < 0.05$ for all tests performed.

3. Results

3.1 Sample description

Variables were analyzed across six groups: sociodemographic characteristics, specific training in PE, adverse effects related to pain and PE, clinical use of the technique, technical application parameters, and perception of the results. Most variables were categorical (nominal or ordinal) and collected via single- or multiple-choice questions. Some open-ended variables were also included, such as the number of vasovagal syncope episodes triggered and the criteria for adjusting session frequency. Only age was collected as a continuous variable. This structure enabled a detailed and coherent descriptive analysis aligned with the set objectives. After data collection, a total of 49 completed questionnaires were collected. The total number of FTs who saw the questionnaire, or the dropout rate from the survey, is unknown because the data collection method did not track or record the reach or the specific participation rate of the invitation.

3.2 Section 1

Analyzing the collection of demographic data, the average age of the participants was 32.9 ± 8.4 years. Regarding gender, 73.5% were men and 24.5% were women. Most participants came from Spain (85.7%), followed by Portugal (6.1%) and Switzerland (4.1%). All respondents were physiotherapists, meeting the inclusion criteria.

In summary, regarding the training received and clinical experience in PE, 39.5% reported having 1-5 years of experience, 27% less than 1 year, 18.7% 5-10 years, and 14.5% more than 10 years (Table 1). 75.5% had received in-person training, and 24.49% had received both in-person and online training (Table 1). Most participants had trained in MVClinic (82%) either as a single training or in combination, followed by multiple combinations including EPI (43%), EPTE (24%), and MEP (8%).

Regarding the duration of training and the frequency of clinical use, 69.39% had completed more than 60 hours of training, 24.49% between 30 and 60 hours, and a small percentage less than 30 hours (4.08%). 2% reported having no specific training in PE, which prevented them from completing the questionnaire due to the inclusion criteria (Table 1). 40.8% of physiotherapists use PE several days a week, 30.7% daily, and 26.5% only occasionally (once a week or less). Table 1.

Table 1. Demographic and professional data.

Years of experience in PE	
Years	Frequency
Between 1 and 5 years	39,58%
Between 5 and 10 years	18,75%
More than 10 years	14,58%
Less than 1 year	27,08%
Type of training	
Training	Frequency
Both	24,49%
In-person	75,51%
Specific training in PE	
Training	Frequency
Between 30 and 60 hours	24,49%
More than 60 hours.	69,39%
Less than 30 hours	4,08%
I don't have any specific training in electrolysis	2,04%

3.3 Section 2

The survey results show that 45,83% of physiotherapists reported that their patients experienced pain during the application of dry needling, with the majority experiencing it very frequently (more than 80% of treatments), followed by 22,92% who observed it often (60–80% of treatments), another 22,92% who detected it occasionally (30–60% of treatments), 6,25% who reported it almost never (less than 30% of treatments), and 2% who said it never occurs (Table 2).

Regarding post-needling pain, 37.50% of respondents reported experiencing it sometimes, 33.33% almost never, 14.58% often, 8.3% frequently, and 6.2% never (Table S3. Post-puncture pain). Regarding the duration of post-puncture pain, 73.5% reported it usually lasts 24-72 hours, and 24.5% said it resolves in less than 24 hours. Table S3. Post-puncture pain.

The worsening of symptoms after the intervention occurs “almost never” according to 54.1% of participants, “never” for 31.2%, “sometimes” for 12.5%, and “often” for 2% (Table 2). Regarding the discontinuation of treatment due to pain intolerance, 54.1% indicated that they “almost never” had to stop it, 39.5% indicated “never”, 4.1% “sometimes”, and 2% “often” (Table 2).

Table 2. Frequency of adverse effects.

Treatment interruption due to intolerance	
Likert	Frequency
Often (60% to 80%).	2,08%
Sometimes (30% to 60%).	4,17%
Almost never (less than 30%).	54,17%
Never (0%).	39,58%
Worsening of symptoms	
Likert	Frequency
Often (60% to 80%).	2,08%
Sometimes (30% to 60%).	12,50%
Almost never (less than 30%).	54,17%
Never (0%).	31,25%
Pain during application	
Likert	Frequency
Often (60% to 80%).	22,92%
Sometimes (30% to 60%).	22,92%
Almost never (less than 30%).	6,25%
Frequently (more than 80%).	45,83%
Never (0%).	2,08%
Mild vegetative reactions	
Likert	Frequency
Often (60% to 80%).	14,58%
Sometimes (30% to 60%).	20,83%
Almost never (less than 30%).	47,92%
Frequently (more than 80%).	4,17%
Never (0%).	12,50%

3.4 Section 3

Regarding adverse effects observed during PE clinical practice, 69.4% of physiotherapists reported bleeding 'almost never,' 18.4% 'never,' and 10.2% 'sometimes.' For hematoma, 69.4% observed it 'almost never,' 24.5% 'never,' and 4.1% 'sometimes.' Accidental nerve puncture was reported as 'never' by 69.4% of participants and 'almost never' by 28.6%. Myoedema was 'never' observed in 69.4% of cases, 'almost never' in 24.5%, and 'sometimes' in 4.1%. Regarding mild vegetative reactions such as sweating or paleness, 47.9% reported that they occur "almost never," 20.8% "sometimes," 14.5% "often," 12.5% "never," and 4.1% "frequently" (Table 2). 45,84% of physiotherapists indicated having observed some vasovagal syncope in their patients, while 54,16% responded that they had never observed it. Among those who responded affirmatively, the average number of syncope episodes observed was 2.7 over their professional careers, with a range of 1 to 10 cases (Table 3). Only one case of adverse effects due to an allergic reaction was reported. Table 3.

Table 3. Vasovagal syndromes according to years of experience.

Years of experience in PE	Without vasovagal syndrome	With vasovagal syndrome	Cases (n)
Less than 1 year	2,08%	25,00%	1
Between 1 and 5 years	27,08%	10,42%	6
Between 5 and 10 years	10,42%	10,42%	19
More than 10 years	14,58%	14,58%	22
General total	54,16%	45,84%	48

3.5 Section 4

Regarding the tissues treated with PE, the most common were tendon (96%), followed by muscle (84%), interfaces (80%), ligaments (73%), septa (59%), fasciae (43%), and other tissues (18%) (Table 4).

Regarding the use of ultrasound to guide the procedure, 93.9% always use it, and 4.1% use it frequently. Among those who use it, 89.8% reported using it in all procedures, and 8% indicated that there are cases where they prefer not to use it. As for the criteria used to determine the target tissue, 93.9% stated that they rely on a combination of clinical and ultrasound findings, while 4.1% rely exclusively on ultrasound findings.

89.8% of physiotherapists indicated that they combine PE with other invasive techniques, and the same percentage stated that they combine it with non-invasive techniques. Regarding combinations with other invasive physiotherapy techniques, the most frequent were neuromodulation (84%) and dry needling (53%), often co-occurring in many cases. Some opted for other forms of electrotherapy (37%) or integrated all three techniques mentioned (Table 4). Electrotherapy alone and other minor combinations were also reported, as with microcurrents. In relation to non-invasive techniques, therapeutic exercise was the most commonly used technique at 86%, followed by different types of radiofrequency (47%), shockwave therapy (14%), manual therapy (12%), and laser (10%), as well as combinations of all these techniques (Table 4).

Table 4. Combined interventions and target tissues.

Combination with invasive techniques	
Techniques	Frequency
Neuromodulation	84%
Dry needling	53%
Other forms of electrotherapy	37%
Microcurrents	2%
Most treated tissue	
Tissue	Frequency
Tendons	96%
Ligaments	73%
Muscles	84%
Interfaces	80%
Septa	59%
Fascias	43%

Combination with non-invasive techniques	
Techniques	Frequency
Exercises	86%
Manual therapy	12%
Radiofrequency	47%
Laser	10%
Shock waves	14%

3.6 Section 5

Regarding the technical application parameters of PE, 85.7% of physiotherapists reported using intensities between 1 and 3 mA, 10.4% reported intensities below 1 mA, and 2% reported intensities between 4 and 6 mA (Table 5). Regarding the duration of the electrical stimulus, 70.8% reported using times of 1-3 seconds, 18.7% more than 60 seconds, 8.2% 4-10 seconds, and 2% 11-60 seconds (Table 5). As for the number of impacts per session, 66.6% apply 1-3 impacts, 20.8% 4-6, 6.2% 6-8, and 6% report other values (Table 5). Regarding the dosing system, 87.8% reported using mA or μ A as a reference, 6.1% joules, 2% coulombs, and 2% other parameters. 94% of physiotherapists schedule 1-4 sessions per pathological process, while 6% schedule 5-10 sessions.

Regarding the criteria used to select the technical application parameters, 100% of the surveyed physiotherapists reported using some specific clinical or technical criterion. 30.6% indicated that they are guided solely by defined protocols, 4.1% rely exclusively on the patient's pain tolerance, and 10.2% rely on the tissue's clinical condition (acute, subacute, or chronic phase). Multiple combinations were common.

Regarding the determination of session frequency, most participants indicated that it is based on the patient's clinical progress, pre-established protocols, the type of tissue treated, the type of pathology, the injury phase, and the response to previous treatment, although responses were open-ended and heterogeneous. Finally, regarding the time to clinical improvement, 46.9% indicated that it occurs within 24 to 72 hours, 34.7% within 3 to 7 days, 6.1% immediately, another 6.1% after more than a week, and 4% provided open-ended responses. Regarding ultrasound structural change, 38.8% indicated that it is observed in the medium term (1-3 months), 28.6% in the long term (>3 months), 18.4% in the short term (<1 month), and 12.2% have not observed structural changes. Table 5.

Table 5. Most used parameters.

Most used impacts	
Impacts	Frequency
1-3 impacts	66,67%
3-5 impacts	2,08%
4-6 impacts	20,83%
6-8 impacts	6,25%
It depends on the target tissue	2,08%
No impacts, constant current	2,08%
Total	100,00%
Most used intensity	
Intensity	Frequency
< 1 mA	10,42%
1-3 mA	87,50%
4-6 mA	2,08%
Total	100,00%
Duration of the most used stimulation	
Seconds	Frequency
>60 s	18,75%
11-60 s	2,08%
1-3 s	70,83%
4-10 s	8,33%
Total	100,00%

3.7 Section 6

Regarding the aspects physiotherapists consider most important for achieving a positive outcome in the application of PE, responses varied and, in most cases, were combined. 71% of the choices include factors related to the procedure, 67% include the condition of the treated tissue, and 61% the combination with other therapies, as well as, to a lesser extent, some open-ended responses such as the quality of the patient's own response (Table 6).

Regarding the most common reasons for treatment dropout, 41.67% of participants identified fear of needles as the main reason. 33.33% mentioned intolerance to pain during the procedure, while 22.83% attributed it to worsening symptoms or a lack of perceived improvement. Only 2% mentioned adverse reactions as a reason.

Regarding the results most frequently observed after the intervention, 82% reported a reduction in pain, 76% primarily noted functional improvement, 16% experienced transient inflammation, and 2% observed no changes (Table 6). Regarding worsening symptoms due to interactions with medical conditions, 20% reported complications from metabolic diseases, 20% from systemic diseases, 18% from psychological disorders, another 14% from chronic pain, 14% from medication interactions, and 2% from other causes.

Finally, compared with non-invasive treatments, 58.3% considered PE much more effective for pain reduction, 31.2% somewhat more effective, and 10.4% similar (Table 6). For functional improvement, 52% indicated that PE is much more effective, 37.5% slightly more effective, 8.3%

similar, and 2% less effective (Table 6). Regarding structural changes, 62.5% indicated that PE is much more effective, 29.1% considered it similar, and 8.3% somewhat more effective. (Table 6).

Table 6. Clinical outcomes and treatment perception.

Criteria for a positive result	
Criteria	Frequency
Factors related to the procedure	71%
Condition of the treated tissue	67%
Combination with other therapies	61%
Observed results	
Results	Frequency
Pain reduction	82%
Transient inflammation	16%
Functional improvement	76%
I don't notice any changes	2%
Effectiveness in producing structural changes	
Effectiveness	Frequency
Somewhat more effective	8,33%
Much more effective	62,50%
Similar	29,17%
Effectiveness in reducing pain	
Effectiveness	Frequency
Somewhat more effective	31,25%
Much more effective	58,33%
Similar	10,42%
Effectiveness in improving functionality	
Effectiveness	Frequency
Somewhat more effective	37,50%
Less effective	2,08%
Much more effective	52,08%
Similar	8,33%

4. Discussion

4.1. Education and Professional Profile

The results indicate that the surveyed physiotherapists have a relatively young profile (32.9 ± 8.4 years), are predominantly male (73.5%), and have a high concentration of MVClinic training (82%). This data, rather than reflecting a generalized trend in PE training, should be considered a potential source of bias, as this study was mainly distributed through networks associated with that institution, which could have influenced the participants' profiles. Therefore, the high concentration of participants trained at the same institution does not make the sample representative of all physiotherapists who use PE, but rather a subset with a common training background. This constitutes one of the main limitations of the study and significantly influences the interpretation of the apparent homogeneity observed in application parameters and

clinical criteria. Most respondents have 1-5 years of clinical experience with PE, and 69.4% have more than 60 hours of specific training. The distribution of years of experience in PE shows that the majority of participants are in the early stages of their careers (66.5% with ≤ 5 years of experience), while fewer than 15% have more than 10 years of experience. This relatively young profile with limited experience may affect the ability to identify rare or late-onset adverse effects and should be taken into account when interpreting safety and perceived effectiveness data. Although there is a difference in professional experience, recent descriptive studies indicate that most physiotherapists who use invasive techniques, such as PE, have specific postgraduate training and several years of professional experience^(12,14,15).

Furthermore, an important finding was that 75.5% of the participants had received only in-person training, while only 24.5% had received hybrid training. This could have implications for the transmission of practical skills, as the safe and effective management of PE likely requires skills in anatomical localization and mastery of the technique, primarily acquired through in-person, supervised training^(13,16,17). In line with other studies, this reinforces the need for in-person programs that include technical components as well as aspects of clinical reasoning and safety⁽¹⁴⁾.

In this regard, it should be noted that although the inclusion criteria required training in PE, 2% of participants reported not having specific training. These occurrences in open surveys, already documented in other cross-sectional studies, suggest that professionals who access the questionnaire without strictly meeting the established criteria cannot constitute a valid sample, reinforcing the need to implement automatic filters on data collection platforms⁽¹⁷⁾.

4.2. Adverse effects related to pain

Regarding adverse effects related to pain, physiotherapists reported that their patients experience pain during the puncture frequently or very frequently in 44.9% of cases. This result is consistent with the usual pain associated with the procedure, specifically needle insertion. This frequency is similar to that reported in studies on dry needling, in which pain during the intervention was among the most common events⁽¹⁸⁾. Likewise, 73.5% of physiotherapists reported that post-puncture pain lasted 24-72 hours, data similar to previous literature on the inflammatory effects of invasive techniques⁽¹⁸⁾.

Regarding the worsening of symptoms after the session, 54.1% indicated that it had never or almost never occurred. Similarly, 54.1% of respondents stated they had never had to interrupt a treatment due to pain intolerance at any point in their career. In contrast, only 2% reported having done so sometimes or often. These data can be understood in the context of the technique's safety and the expected response to a procedure combining controlled injury and galvanic stimulation. It is worth noting that a significant proportion of these effects may be due to activation of the autonomic nervous system and neurovegetative phenomena related to pain and acute stress, as previously described in studies on myofascial dry needling and PE^(5,12,19). This type of response, although potentially alarming for the patient, usually does not indicate a clinically relevant event if it resolves quickly and does not cause sequelae.

4.3. Adverse effects associated with needling and PE

Regarding the specific adverse effects of the technique and the needling process, the study's interpretation indicates that bleeding and hematoma are infrequent but relatively common. These data are consistent with other invasive procedures, which consider these effects minor and self-limiting, particularly when fine needles are used, and aseptic techniques and ultrasound control are followed^(20,21). 36.7% of respondents reported having experienced a vasovagal syncope at some point during their professional life, with an average of 2.7 episodes per professional. Although it is a notable percentage due to its prevalence, it should be taken into account that the data analyzed covers an entire working life, similar to what has been documented for other invasive techniques^(14,17), and therefore a higher number of events among professionals with more years of experience only indicates a greater number of accumulated cases due to the more extended period of professional practice, although it could be expected that the actual number of cases decreases as work experience increases. However, this aspect was not captured in the questionnaires, and future studies could address it. The occurrence of vasovagal syncope is related to emotional factors, pain hypersensitivity, or vagal stimulation, whether or not associated with pain provocation. It is important that these events are reported in the informed consent and that preventive measures are taken during practice^(22,23).

Regarding serious adverse effects, such as infections, burns, or allergic reactions, only one case of an allergic reaction was recorded, well below rates reported for non-sterile invasive procedures in other disciplines, such as acupuncture or dry needling⁽¹⁹⁾.

4.4. Application criteria and combination with other therapies

The surveyed physiotherapists apply PE mainly to tendons, but also to muscles, interfaces, and ligaments, reflecting an expansion of use beyond the classic tendon approach. In this regard, the findings are consistent with data from similar literature, highlighting the progressive diversification of therapeutic targets and the recent evolution of the different tissues treated using galvanic current, provided there is a functional and structural justification based on clinical and ultrasound findings, as reported by 93.9% of the participants in the sample^(16,22).

Regarding the combination with other techniques, 89.8% of respondents integrate PE with invasive techniques such as neuromodulation, dry needling, or electrotherapy, and the same 89.8% with non-invasive interventions, highlighting therapeutic exercise, present as a combined technique in 86% of cases. This finding reinforces the need to consider PE within a multimodal intervention model, in which clinical reasoning integrates different tools according to the type of injury, the patient profile, and the therapeutic objective, without abandoning reference to established clinical protocols or the importance of the mechanical effect in the treatment process^(24,25).

4.5. Technical parameters and selection criteria

Regarding technical parameters, most physiotherapists reported using intensities between 1 and 3 mA (85.7%) and application times of 1 to 3 seconds (70.8%). These values coincide with the general recommendations of methodologies such as MVClinic. In terms of dosage, the most common number of sessions was 1-4 per disease process (94%), and the most common num-

ber of impacts was 1-3. This apparent uniformity suggests a certain degree of clinical consensus in the use of the technique, which could be interpreted as a basis for moving towards a more robust standardization⁽²²⁾. However, this homogeneity may be influenced by the common training context of many participants and by the limited sample size. With a larger and more heterogeneous sample, more diverse results could have been obtained in clinical practice.

Regarding the criteria for selecting these parameters, all the physiotherapists surveyed reported following some protocol or clinical criterion, highlighting the influence of factors such as injury stage, pain tolerance, and previous experience. Although some earlier studies supported the predominance of individual reasoning over rigid protocols, in the current context, there is a trend toward integrating both approaches. In other words, it starts from a protocolized base tailored to the patient's characteristics and pathology, as suggested by recent studies⁽¹⁵⁾. In another open-ended question on the criteria for treatment frequency, the most common responses focused on protocol selection, pain-based patient progress, and tissue regeneration physiology. Although our sample shows an apparent homogeneity in application parameters, this finding likely reflects the influence of a shared training methodology rather than a genuine consensus among the different schools and training lines in PE. Currently, there is no universally accepted protocol due to the coexistence of different dosing proposals across different reference schools.

4.6. Clinical outcomes, treatment perception, and dropout

In the observed clinical outcomes, physiotherapists primarily show a combined improvement in pain reduction (82%) and functionality (76%). This reinforces the perception of PE as an effective intervention in addressing musculoskeletal disorders, especially tendinopathies^(5,12,18). Regarding the factors that physiotherapists consider most relevant for a positive outcome with PE, most participants indicated that the combination of variables, such as the technique used, the condition of the tissue, and the combination with other therapies, is the primary determinant of success. These results may be related to current multifactorial perspectives, which advocate integrating PE into an individualized patient approach while respecting the clinical protocol⁽²²⁾. At the same time, 18.8% prioritized the technical procedure exclusively, and 10.4% prioritized tissue condition. These differences reflect reasonable clinical variability and the need to continue advancing toward standard criteria for outcome evaluation.

Regarding treatment dropout, the main reasons were fear of needles (41.67%) and intolerance to pain during the procedure (33.33%). This can be related to previous results from other techniques, such as dry needling, where the patient's emotional and perceptual components decisively influence treatment adherence^(14,19). Additionally, 22.83% reported worsening of symptoms or lack of perceived improvement, highlighting the importance of education and expectation management before starting treatment. Regarding the interaction of PE with pre-existing medical conditions, 20% of FT reported observing clinical worsening in patients with metabolic diseases (such as diabetes or hypothyroidism), followed by systemic diseases (20%) and chronic pain (14%). These interactions have previously been described in patients with alterations in inflammatory regulation or central sensitization, which may affect treatment response^(20,21,26).

The physiotherapists evaluated the effectiveness of PE compared to other non-invasive treatments. Regarding pain reduction, 58.3% considered PE to be much more effective, and 31.25% thought it somewhat more effective, resulting in a very favorable overall outcome. Regarding functional improvement, 52% perceived it as much more effective, and 37.50% as slightly more effective. Finally, concerning structural changes observed via ultrasound, 62.5% believed that PE is much more effective than other non-invasive techniques, followed by 29.1% who considered it similar, and 8.3% who perceived it as somewhat more effective. These results demonstrate high clinical confidence in the technique's usefulness, especially its ability to induce structural changes⁽¹⁵⁾.

4.7 Future research lines, limitations, and strengths of the study

Although PE is a safe and increasingly used technique in the clinical setting, many aspects remain to be explored. Interestingly, future research compares its effectiveness with that of other physiotherapy interventions to better understand in which cases it provides real added value. Standardizing protocols is necessary to unify application criteria without losing the ability to individualize the intervention. Finally, the analysis should be applied to a larger sample, which would allow these results to be extrapolated and continue building a solid scientific basis for its use. The final sample size ($n = 49$) was much smaller than the initially calculated value, and most participants came from the same educational institution. Consequently, the results should be interpreted as exploratory and are not generalizable to the broader population of physiotherapists who perform PE. In addition, the fact that recruitment was carried out predominantly through a database linked to a single training institution likely underrepresents physiotherapists trained at other schools and with different application protocols. Likewise, although 95.8% of physiotherapists reported using ultrasound to guide PE, no data were collected on the extent of specific training or on the level of ultrasound competency. This lack of information may affect the interpretation of results related to safety and adverse effects, given that the quality of ultrasound management is a determining factor in this area.

This study represents an essential step toward understanding PE, as it is the first to systematically analyze how this technique is applied in real clinical practice. One of its main strengths is its broad, integrative approach, which allows the collection of relevant information not only on the technical parameters and the tissues treated, but also on professional training, the occurrence of adverse effects, and perceptions of effectiveness. This comprehensive approach provides a clear picture of the current use of the technique and can serve as a basis for future clinical and scientific improvements.

Despite its contribution, it is crucial to consider its limitations. On the one hand, the number of participants was lower than the estimated sample size in the study design, limiting the ability to generalize the results to the entire profession. Furthermore, PE is a technique that, to date, is not widely implemented among physiotherapists. Its use necessarily requires ultrasound and, within this, specific training in ultrasound-guided invasive interventions, which limits the number of professionals qualified to apply it. This makes accessing a large sample particularly challenging. It should also be noted that this is a self-administered, anonymous survey, which may introduce biases.

5. Conclusion

This study has provided a detailed understanding of a first descriptive approach to how PE is used in the routine clinical practice of the collected sample. The surveyed physiotherapists, who have mostly homogeneous training, demonstrate solid expertise and frequently apply the technique in combination with other interventions. In this sample of 49 physiotherapists, PE is perceived as an effective technique, especially for reducing pain, improving function, and promoting tissue structural changes. In addition, adverse effects are infrequent and, for the most part, mild and self-limiting. However, the small sample size and selection bias limit the generalizability of these results.

Despite the variety of clinical criteria, there is a general trend toward the use of standardized protocols tailored to the patient. These findings add to the value of PE as an effective and safe tool for the treatment of musculoskeletal disorders and open the door to future research to further improve its clinical application. Finally, it is worth noting that, while PE treatment is perceived as safe and effective, there is still a significant margin for improvement in the standardization of practices, the prevention of adverse effects, and the individualization of therapeutic approaches, as the small sample sizes, lack of representativeness, and absence of information on the level of ultrasound competence require these results to be interpreted with caution. Studies with larger and more heterogeneous samples are needed to confirm or refine these findings.

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Ethics Committee

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Universidad San Pablo CEU (approval granted on May 6, 2025, code 1001-25 TFM).

Informed Consent of the Patient

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